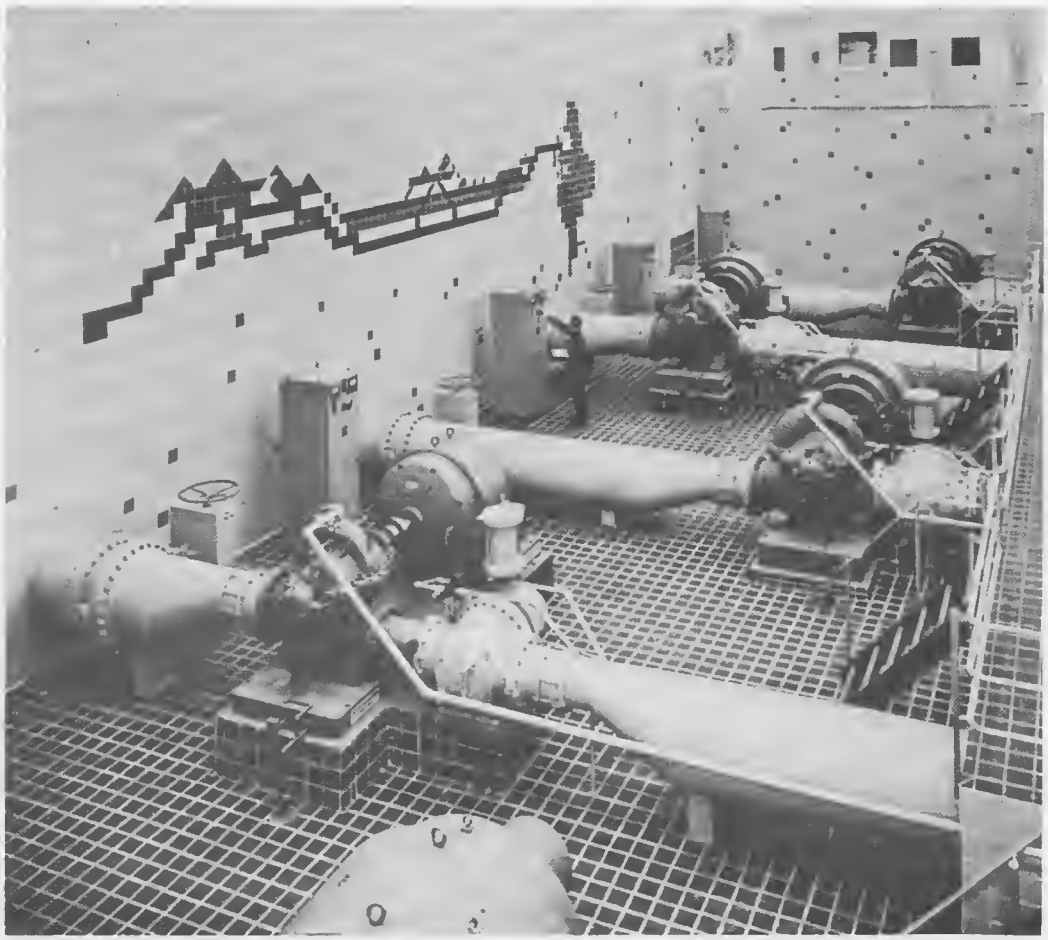
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ECL 160

EXPANSION OF THE DANVILLE PUMPING PLANT



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Expansion of the Danville Pumping Plant

Although seventy percent of the earth's surface is covered with water, drinkable water is not common. Sea water has too high a salt content, and few of us live close to a lake or stream. Today many rivers have been polluted to the point where the water is hazardous. Well water must be continually checked for contamination.

We take for granted that any faucet will always deliver potable water. The only time we give water a thought is when it shows signs of containing a little dirt. It is a tribute to modern engineering that the tap water is there when we want it. Such a situation requires development of watershed regions, holding reservoirs, aqueducts to carry the water from the reservoirs to the populated areas, filter plants and pumping plants to clean the raw water so that it is fit for human consumption, and pumping it to distribution reservoirs.

In central and southern California, several cities have banded together to form municipal utility districts. Each district is given the responsibility for supplying water to its consumers, both private and industrial, residing within its bounds.

One such district is the East Bay Municipal Utility District which provides industrial and residential water service for much of Alameda and Contra Costa counties in California. The district is charged with the responsibility of developing and maintaining water sheds in the Sierra mountains, transporting and preparing the water, and furnishing it to the customers.

The East Bay Municipal Utility District draws its water from Pardee reservoir located high in the Sierra mountains. Water is brought down through three large aqueducts called the Mokelumne aqueducts to five large holding reservoirs (actually lakes) located in the mountain range east of Oakland, California. These five reservoirs have a total holding capacity of 51.3 billion gallons. Water is then piped through a number of water treatment plants where it is purified and then pumped to various distribution reservoirs located throughout the district. From these reservoirs the water flows by

gravity to the individual user.

Because of the gravity distribution system from the distribution reservoir to the user, the district has been divided into a number of zones, each representing a different altitude. A zone seven reservoir (for example) might serve customers whose taps are located from 100 to 300 feet below the level of the reservoir. The minimum height of 100 feet between reservoir and user is selected to insure that the water pressure will be adequate, and the maximum height is selected such that the water pressure will not be so severe as to cause damage to water heaters and other units.

Distribution reservoirs are added as population increases. The district must anticipate the changing water demand and build pumping plants and reservoirs in advance of the population increase, so that when people arrive, the water will be there. The job of forecasting water demand for the district is the responsibility of the Water Resources group within the district.

When the Water Resources group has projected a population increase for a given area, it then attempts to estimate the increased total plant capacity which will be required to handle that area, the date on which the initial increase in capacity will be needed, and the date on which the total projected increase in capacity will be needed. This information is passed to the engineering department of the district in the form of a Construction Project Control document which authorizes the engineering department to perform an engineering analysis of what new plant facilities, such as pumping plants and reservoirs, will be needed to handle the projected increase.

One such expanding area is the Danville-San Ramon area of southern Contra Costa County. This area was annexed to the district in 1958. In early 1959 the Water Resources group estimated that the ultimate demand would be 30 mgd* and so in late 1959 the first Danville pumping plant was designed and constructed to handle this area. It consisted of five pumps, each having a capacity of approximately 3 mgd, yielding a total plant

*mgd stands for million gallons per day.

capacity of between 9 and 10 mgd.

The population in the Danville-San Ramon area refused to follow the prediction curves. In 1962 a re-survey indicated that the ultimate demand for the area served by the Danville Pumping Plant would be 45 mgd. In 1963 a second survey indicated that the ultimate demand should be upped to 65 mgd. In 1965, because of an expansion of the district boundaries in the area, a third survey indicated that the ultimate demand for the area would be 120 mgd - a value four times that predicted in 1959.

In 1963 (at the time of the 65 mgd estimate) a Construction Project Control document had been released by the Water Resources group authorizing the engineering department to begin work on the design of new facilities to handle the new anticipated water requirement. The district was aware that there was a possibility of a further increase in the area to be served by the water company, but no one had any clear idea of what the increase would be, or when the boundaries of the district would be enlarged. It was decided that the civil engineering department should size the piping for the pumping plant at 85 mgd (an increase of 20 mgd over the anticipated demands of the area) so that if the boundaries were enlarged, the new construction could be kept to a minimum. On this basis, the civil engineering department proceeded to design the piping, and the mechanical engineering department was charged with increasing the capacity of the Danville Pumping Plant from 10 to 65 mgd.

Pumping plants are usually designed so that several pumps are working in parallel, as shown on the frontispiece. This is because the water demands by the users are not constant, but vary according to the time of day and the season of the year. For example, a maximum day demand might be 10 million gallons, an average day's demands 5 million gallons, and the minimum day's demands 2 million gallons. Using a number of pumps in parallel permits the pumping rate to be adjusted simply by adjusting the number of pumps in service. It also permits pumps and motors to be shut down for repair, when necessary, without taking the plant out of service.

When the mandate to increase the pumping plant size to 65 mgd was received by the mechanical engineering

department, the layout for pump selection was made by Mr. Arthur Murray, a senior mechanical engineer within the district. Mr. Murray completed two studies, one for a 30 mgd plant and a second for a 65 mgd plant. In 1964 the civil engineering department released the 85 mgd piping for construction. At this time Mr. Murray had completed his design studies for the pumping plant and retired from the district. Upon his retirement, Mr. Ed Carville, a mechanical engineer, was promoted to Mr. Murray's position and assigned the problem of the Danville Pumping Plant.

Mr. Carville had received his bachelor of science degree in mechanical engineering from Loyola University in Los Angeles in 1957. Upon graduation he went to work for the Western Gear Company as a mechanical engineer in their design section. He later transferred to the Hydro-aire Company in Burbank, California, then to the National Seal Company in Redwood City, California, and in 1961 came to the East Bay Municipal Utility District as a design engineer in the mechanical engineering section. When Mr. Carville joined the district, he was first assigned the finishing details of the Sobrante Filter Plant and part of the work on the Maloney Pumping Plant. This work prepared him to assume Mr. Murray's duties in 1964.

In 1965 Mr. Carville received the word that the district boundaries were enlarged, and that the anticipated demand was 120 mgd. He was, therefore, required to discard Mr. Murray's studies and initiate a new set of studies for the enlargement of the Danville Pumping Plant. The Water Resources Group estimated the usage as listed on page 1 of Exhibit 4.

Mr. Carville also knew that storage in the Danville area in 1965 was 17.5 million gallons, and that the Alamo Reservoir was scheduled to add an additional 10 million gallons in 1971, with a second projected reservoir to add an additional 3 million gallons by 1975. The projected storage for 1975 was about 30 million gallons.

Even though the anticipated ultimate demand was 120 mgd, Mr. Carville planned to design the pumping plant so that the capacity could be increased in stages. The reason for this is simple; idle capacity (pumps not being used) would cost the district money. A good design would call for the purchase and installation of new pumps as the area demand increased, rather than installing the

ultimate plant at one time. In this way the district's money could be spent as needed, and funds would not be tied up in pumps and motors which would stand idle from five to fifteen years.

Mr. Carville aimed his initial analysis at a first increase to a plant capacity of 40 mgd, followed by a later increase to 120 mgd.

As Mr. Carville saw them, the design constraints for the pumping plant were:

1. Ultimate plant capacity.

2. Initial desired plant capacity.

3. Anticipated rate of capacity increase.

4. Land available for the expansion.

5. Total cost of the pumps and motors.

When any pump and motor are selected, their useful life is anticipated to be 25 years. Therefore, the operating costs of the pump (the number of dollars required to pump a gallon of water from the plant to the holding reservoir) can be a consideration in excess of the original purchase price of the unit. Furthermore, over the 25 year period, maintenance costs of the pumps may be a significant fraction of the total cost. In pump selection, one must add the original cost, the operating costs (energy costs) and the anticipated maintenance costs of the unit to arrive at the total unit cost.

Land considerations are also important. Pumps in the 450 hp to 1000 hp class are large. The existing Danville Pumping Plant site had an area of about 0.6 acres, and the addition of the 60 inch suction and discharge lines in 1964 would somewhat limit the permissible pump layouts on the site. Mr. Carville had a choice of trying to utilize the existing site, buying adjacent vacant land, and thus increasing the size of the site, or proposing that the district acquire a second separate parcel of land in order to either build a completely new pumping plant, or to build part of the pumping plant on the existing site and another part (probably to be called by a new name) on the projected new site.

Mr. Carville first produced head loss curves based on both the inlet pipe friction and the exit pipe friction of the proposed plant piping. The Civil Engineering Department furnished Mr. Carville with the information as to what pipes would be used, and friction loss data for the pipes was available not only from the standard hydraulic tables, but also from information which had been gathered by the district through actual measurements on its own pipelines over a long period of years. Next, Mr. Carville plotted a number of pump capacity curves onto the system friction curve. These pump capacity curves are pump performance curves. They indicate the number of gallons per minute which a pump can deliver plotted against the elevation (head) through which the pump must deliver water. An example is shown in Exhibit 1. When Mr. Carville plotted the capacity curves on the system friction curve, he had an overview of the performance of different numbers and types of units from which he could make his initial selection of pumps. The curves indicated that pumps in the 600 hp to 1000 hp class would be most satisfactory, based on the immediate need for water in the area and the projected rate of increase. It looked as though the district would be wise to install two pumps of the 600 hp class for the initial expansion, and then later install pumps of approximately 1000 hp each as the water demand increased in the area.

Generally speaking, pumps may be classified as either positive displacement or kinetic. Water plant pumps are always kinetic pumps and may be radial flow, mixed flow, axial flow, and single stage or multi stage. These may be driven by electric motors or natural gas engines. Mr. Carville's first choice of pumps was a type generally known as a horizontal split case pump (Exhibit 2) which is usually powered by a gas engine. The term "split case" refers to the fact that the pump casing itself is made in two halves which are bolted together at the time of the assembly of the pump. A split case pump may be radial flow, mixed flow, or axial flow. This type of pump was preferred by Mr. Carville because the split case allows easy access to the interior of the pump for maintenance. In general, split case pumps are a well developed line of pump. They have been used for many years, and their reliability is quite good. This is also true of the natural gas engines which are usually used to power them. The engines have been "married" to the pumps, and the district's experience with this type unit has been good in the past. The basic disadvantage

of a horizontal split case pump and engine combination is that the unit takes up much more floor space than a vertical pump, and split case pumps are usually furnished only as single stage units.

Mr. Carville's first alternate was a vertical pump with a vertical drive. An example of this kind of pump is shown in Exhibit 3. These pumps are either axial flow or mixed flow pumps, and have the advantage that comparatively little floor space is needed to install the units. They have the disadvantage that access to the pump for maintenance is not as convenient as with the split case type, causing an automatic increase in maintenance cost, but they can be built as multi-stage units, whereas the split case pumps are usually limited to single-stage units.

A third alternative which was considered by Mr. Carville was a vertical pump with a horizontal drive. In this particular arrangement the floor space required is midway between the vertical turbine pump and motor and the horizontal pump with horizontal engine. The major disadvantage to this type of unit is that an angle drive must be purchased and installed between the horizontal motor shaft and the vertical pump shaft. Angle drive costs are quite high; they average between $7 and $10 per horsepower, and the losses in the angle drive can amount to as much as 3 percent in overall pump efficiency. This means an increase both in purchase price and operating cost in the unit, as compared to either of the other two units described. This makes this type of unit the least satisfactory of the three.

The gas engines available for pump drives include both two cycle and four cycle engines. These are made by a number of companies and have a history of good reliability. In the 400 to 1000 hp class, there are three types of electric motors which can be used. These are the synchronous motor, the induction motor, and the wound-rotor motor. The wound-rotor motor has the advantage that it is a variable speed motor, coupled with the disadvantage of comparatively low efficiency and high initial cost. In smaller pumps the induction motor is the standard unit; but in the larger sized, the synchronous motor is preferred, since the power factor can be adjusted to minimize operating costs.

The energy cost differential between natural gas and electricity is not as simple as might be expected. Natural

gas has a fixed price per BTU, but electric energy costs are based on varying rate schedules. If the consumer uses electricity during the off-peak hours (which occur in the middle of the night), the power company will agree to supply electric power at a rate of about 1.0 cent per KWH. If electric energy is desired during peak demand hours, the costs will be higher. The economic use of electric power dictates that electrically driven pumps be used at night and shut down during the day. If Mr. Carville chose to select electrically driven pumps, then he had to consider whether it would be more economical to install large (and initially more expensive) pumps and motors which could supply the area by pumping only during the off-peak hours, or install smaller, cheaper units which would pump continuously at a higher KWH cost.

Installation of natural gas engines to drive the pumps would yield fixed energy costs, and the gas engines could produce varying pump outputs by simply varying the engine's speed. Mr. Carville knew that if he selected natural gas engines, his gas costs would be based on either continuous service, or interruptable service. Interruptable service means that the gas company agrees to furnish natural gas at a slightly lower rate, but that the customer agrees to discontinue using the gas during the times of peak gas consumption. Peak consumption occurs on cold days when residential users are running their furnaces full blast. The district could afford to utilize the interruptable service rate, since water demands are a minumum on the days when gas demands are a maximum.

One disadvantage of the interruptable service is that the gas company requires the customer to install a standby LPG tank, and local building codes required a 25 foot separation between the LPG tank and any building or property line. This would be an important consideration on the 0.6 acre Danville site.

With all these things in mind, Mr. Carville prepared his analysis for the expansion of the Danville Pumping Plant. He proposed six alternatives, basing the costs for each alternative on both continuous pumping and intermittent pumping. His proposals included one electric drive for vertical turbine pumps, three gas engine drives for horizontal pumps, one gas engine drive for a vertical pump, and a combination proposal which included all

horizontal pumps, four of which would be driven by gas engines and four by electric motors. His analysis and summary are presented as Exhibit 4. His recommendations were that the existing plant be kept in service, but that the units be retired in case of failure. He further recommended that the new plant be built with horizontal pumps and natural gas engines on the present site (his alternate B) which would require purchase of the adjacent parcel; or if the adjacent parcel could not be purchased, he recommended building half of the plant on the existing site and half on a new site (his alternate C).

This proposal was reviewed in late December 1965 by Mr. Ran Pierce, a senior mechanical engineer. In general, Mr. Pierce felt that electric energy costs would remain fairly constant in the forseeable future, while the cost of natural gas could be expected to rise. He also raised the question of noise and odor. Electric plants are completely acceptable on these two points, but natural gas engines are not. In order to use natural gas engines, Mr. Pierce felt that the district would be forced to pay particular attention to the design of the building housing the pumping plant, and he was none too sure that the noise level and amount of odor could be kept at an acceptable value.

Shortly after Mr. Pierce had released his comments, the area served by the existing Danville Pumping Plant reached a peak usage of 11 mgd* with an average usage of 5.5 mgd. It was time for the district to begin enlarging the plant.

In March of 1966, two new design considerations began to appear. These were the outward appearance of the pumping plant and the potential noise problem. In order to understand why these were considered as serious design constraints, it is necessary to know a little more about the operation of the district.

*Remember, even though the pumping plant can supply only 10 million gallons in a 24-hour period, the reservoir capacity was 17.5 million gallons. The maximum day demand was 11 million gallons, but the demand on the day following was less. The 10 mgd pumping plant could not keep the reservoir full, but the reservoir was certainly not emptied on the maximum demand day.

The East Bay Municipal Utility District is a service organization whose physical plant is scattered through both residential and commercial areas. The intrusion of the plant facilities into residential areas requires that the district be cognizant of whatever impact its facilities may have on the residents of a given area. For many years the district has included landscaping costs in the construction of filter plants, and distribution reservoirs. The district has been proud that its facilities would be reasonably harmonious with their surroundings. To insure that the district operations are acceptable to the community, the East Bay Municipal Utility District maintains a customer relations department whose function is to accumulate complaints from the people residing within the district and then see that the proper department takes appropriate action to correct. Complaints may come in over the telephone or to the district business offices from the company's customers. Other suggestions come in from district management itself. No matter where the complaints are generated, they are accepted by the customer relations department and forwarded to the appropriate section for action. Occasionally the situation will be such that no action can be taken; for example, once a building is in place, it is extremely difficult to tear it out and start over. In a case like this, the error stands as an ugly beacon for all the engineers to see and remember.

For example, in 1956, the district had installed a pumping plant containing submersible pumps. The decision to use submersibles was based on noise considerations. The district felt that using submersible pumps and constructing a semi-underground pumping plant would significantly decrease the pumping plant noise. It was found that the sound of the pumps was negligible and, therefore, satisfactory; but the overall appearance of the pumping plant was objectionable. The engineering department was, therefore, cautioned to pay attention to the esthetic appearance of any structure belonging to the district which might be constructed in the future.

Pumping plant noise level had been of some concern to the district since the 1950's, and by 1965 the engineering department considered the problem to be a major one. People were moving into the area served by the district at a rate estimated to be 800 new residents per day. The pumping plants were no longer in "remote" areas; the expanding population was beginning to build

closer and closer to the pumping plant sites. This "population pressure" was increasing the magnitude of the noise problem. New installations would have to be designed with noise in mind; but the district did not have sufficient data on its pumping plants from which to predict noise levels. It would be necessary to gather such data.

On March 1, 1966, Mr. Carville initiated a noise level study. The purpose was to determine the noise level of the existing Danville Pumping Plant and from that anticipate how much of a noise level increase would be acceptable to the area residents when the plant capacity was increased. Mr. Carville sent out a man with a db meter to measure the night time sound level. It was found that with the pumps shut off, the all pass sound level was 51 db (equivalent to NC32 sound level). This is an extremely low noise level. Sound levels had been measured at other pumping plants utilizing gas driven pumps. In one such plant, the pumps were installed in a concrete building containing acoustical doors and acoustical baffling. To decrease sound level in this plant the district had found it necessary to prevent any un-baffled openings into the building. This meant that the pump motors could not be cooled by a high speed change of air through the building. It was necessary to install a "water radiator" to transfer the heat generated by the motors to a cooling water system. The building had to have at least one opening so that the air could be changed. These were provided by an "air well," a pipe dropping below the existing grade followed by two 7-foot sound trap sections and acoustically balanced units to kill any sound coming through, exiting into the building.

On July 8, 1966, Mr. Pierce sent copies of a proposed noise level specification which had been worked out by himself and Mr. Carville to each of the motor and pump manufacturers with which the district regularly did business. Mr. Pierce explained that the district's installations were primarily in residential areas and noise was a problem. He indicated that a new pumping plant was under design and that the specification for the plant would include a paragraph regarding the sound pressure level of the motors. He asked each of the companies to comment as to the practicality of the requirements, possible price increase if the paragraph were included

in the specification, and estimated increase in delivery time of the pumps. Mr. Pierce's letter and replies from three companies are attached as Exhibit 5. After further discussion the sound power level requirements for the motors were stabilized at 95 db in the 30 to 120 cps band, and 100 db in the 150 to 8000 cps band. These were included in the specifications as paragraph 4.05, paragraph 5.05, and section 7 dealing with the manufacturer's responsibility for measurement.

Since Mr. Carville envisioned that the Danville plant would contain two 950 hp gas engine drives (his alternate B), he had sound measurements made on the largest water pump which he could locate. This was a 3500 hp, 900 rpm motor located in the South Bay Aqueduct Pumping Plant near Byron, California. At 6 feet from the motor the overall noise level was 100 db. From this Mr. Carville concluded that large motors emit large sounds, and, therefore, the motors for the new pumping plant would require some sort of quieting treatment themselves in addition to the acoustic baffling proposed for the building. Since he did not have data on intermediate motors, he requested that the district's architects contact Dr. Walter W. Soroka, a professor at the University of California, and ask him to predict what the noise level would be with the projected pumping plant in operation. Dr. Soroka summed his findings in a letter to the district's architects, which is attached as Exhibit 6. Dr. Soroka indicated that either the wall thickness of the building would have to be increased from 12 inches to about 50 inches, or the motors would have to be enclosed in a box which would give a 20 db transmission loss.

Just after this study had been received by Mr. Carville, the district issued a procedure entitled, "Appearance Considerations for New Facilities." The stated purpose of this procedure was "to insure that the final design of all above ground facilities incorporates landscaping, architectural treatment, and a layout which is in keeping with its surroundings and gains general public approval." Four days later, on September 1, 1966, a meeting was held at the offices of the Contra Costa County planning commission by several property owners who wished to change the zoning of their property to build high rise apartments. The general area to be rezoned encompassed the Danville Pumping Plant site. The district was invited to the meeting, and Mr. Carville and Mr. Ran Pierce accepted

the invitation. Mr. Carville was under the impression that the invitation had been extended so that the district might be continually informed as to what was going on in the area. The district's participation was expected (by Mr. Carville) to be limited to listening and absorbing whatever information the other parties had to offer. Much to Mr. Carville's surprise, he and Mr. Pierce were invited to explain the district's plans for the pumping plant property. On this note, Mr. Pierce stated that the new plant was to be built on the site, but that steps had been taken to keep the noise level of the new plant at a level no higher than the present noise level when the pumps were shut off. Mr. Pierce had been taken by surprise at the invitation to speak, and his remarks were "off the cuff", but the statement as to expected noise level was remembered by the property owners, and the district was forced to live with it. Mr. Pierce summarized the meeting in a memorandum dated September 15, 1966, attached as Exhibit 7.

In the same month the district had decided against attempting to secure more land for the pumping plant site. Mr. Carville was now limited to the land available and the noise level constraint which the district had, in effect, imposed on itself. These two factors effectively eliminated the gas driven pumps from consideration and left Mr. Carville with the electrically driven vertical turbine pumps which he had suggested as alternate A. His proposed requirement had been two 600 hp pumps for the initial installation, giving an increased capacity of 31 mgd. Other engineers pointed out to Mr. Carville that 600 hp pumps would take a large "bite" out of the water supply, and it was finally decided that overall best performance would be achieved by installing two 400 hp, 10 mgd units plus one 1000 hp, 24 mgd unit. This would give the pumping plant initial increase in capacity of 44 mgd. The bid requests were prepared for the two 400 hp units and the 1000 hp unit.

The 1000 hp unit was included at this particular time because three of the five pumps at the existing Danville Pumping Plant were currently out of service. At the time Mr. Carville made his original analysis, he had assumed that all of the existing pumps would be kept in operation. His analysis, therefore, proposed a delay in the installation of the larger pump until increased water demand in the area required it. The loss of 60 percent of the existing pumping capacity coupled with poor maintenance records on the other existing pumps dictated the earlier installation of

the 1000 hp pump. Disregarding the two existing pumps which the district felt were unreliable, the new plant would have three units. This is the minimum number desirable in any pumping plant, since it allows one pump to be used as the base pump, a second pump to be put on the line during peak pumping demand, and a third pump available as a spare.

Mr. Carville anticipated that the requirement for a quiet 1000 hp vertical synchronous motor would drastically reduce the number of bidders for this particular job. However, in late September, 1966, bid requests were sent to approximately 20 vendors of which 7 returned bids. Mr. Carville's purchase estimate was $63,000.

The district solicits bids from a large number of vendors on any project. Since it is a public utility it may not "sole-source" any bids, i.e., all purchases of large equipment must be on a competitive basis. Vendors on the district's bid list have either a history of supplying reliable products to the district, or can furnish evidence that other purchasers of their products have found it satisfactory. The twenty vendors on the pump and motor bid list were fully qualified to produce the type of pumps and motors which the district wanted.

The bids were opened on October 25, 1966. Mr. Carville found his anticipated $63,000 purchase price for the three pumps and motors had been exceeded by six of the seven bidders, but that the Hitachi Company, a Japanese manufacturing company, submitted a firm price of $48,940. This bid was $22,000 less than that submitted by the second lowest bidder.

Although Mr. Carville liked the price, he had some reservations about accepting the bid because the district had never installed Japanese manufactured pumps before. He did not know what difficulties the district would experience in attempting to deal with a foreign manufacturer. Furthermore, the pumps and motors were being produced to the Japanese Industrial Standard rather than an American standard with which Mr. Carville would be familiar. The Hitachi Company agreed to overcome this difficulty by furnishing a translation from the Japanese Industrial Standard to the American Water Works Association Standards.

On November 15, the district decided to accept the Hitachi bid.

On January 10, 1967, the district released a Construction Project Control document authorizing the expenditure of $592,800 for the construction of the new Danville Pumping Plant. At this time the purchase order for the pumps and motors was released to the Hitachi Company.

On January 17, 1967, the work authorization to construct the pumping plant was released. The pumps were scheduled to be delivered in the United States in January of 1968.

During 1967, Mr. Carville and the Hitachi Company were engaged in a flurry of correspondence concerning the construction and testing of the pumps. The first problem which arose was the question of pump testing. In the United States, standard procedure is to set up a venturi and measure the flow through it. Hitachi did not have a venturi of sufficient size to check the 1000 hp pump flow and asked Mr. Carville whether weir flow would be an acceptable test. Mr. Carville did not know, and no one in the engineering department was completely sure whether or not it would be satisfactory. Since Hitachi did not have the necessary venturis, then the weir tests would have to be the ones used.

Problems of this nature were typical of those encountered between Mr. Carville and the Hitachi Company. In general, the problem was that Japanese manufacturing methods and procedures are slightly different from those employed in the United States. All of the correspondence between Mr. Carville and Hitachi concerned itself with these differences.

As the year wore on, the Hitachi people were forced to make several revisions in their pump design before the pumps would meet the specifications supplied by the district. Hitachi was forced to revise the impeller design on the 1000 hp pump to bring the pump up to the performance promised.

Eventually all of the details were worked out and the two 400 hp pumps and motors were received in the United States in January of 1968. The pumps were

delivered to the job site in their original packing crates. The district did not open them or inspect them until time for the contractor to install the units. The purpose of retaining the original packing was to insure that the motor windings would remain dry until such time as they could be installed in their proper enclosures. At the present time, March 1968, the pumps and motors are installed, but electrical power has not yet been furnished to the Danville Pumping Plant. Initial testing of the two 400 hp pumps was scheduled for May 15, 1968. The 1000 hp pump is scheduled for delivery in the U. S. late in the summer of 1968.

1969. Addendum:

The pumps were installed under the supervision of a Japanese engineer, and their initial performance was up to expectation, but there was a slight whining in the pumps. The Japanese engineer suspected that this whine was caused by a vortex on the suction side of the pumps. The District built a cone and installed same in the suction barrel of the pump. This eliminated the whine and was the only problem connected with the pumps.

The noise level is apparently acceptable. There have been no complaints received by any members of the District from the surrounding community concerning the noise. The pumping plant is run intermittently, since its main job is to bring the distribution reservoirs up to their required levels, and this intermittent use probably helps to alleviate any complaints which the neighbors might have.

The only trouble found when the pumps were tested was the intital whining discussed above. The District has had no difficulty with the pumps since that time.

CHRONOLOGY OF EVENTS

	1959	Water Resources estimates 30 mgd ultimate capacity.
	1959	First Danville pumping plant built. 5 pumps, 3 mgd each.
	1961	Ed Carville joins EBMUD.
	1962	Water Resources predicts 45 mgd ultimate.
	1963	Water Resources predicts 65 mgd ultimate.
	1964	Installation of natural gas engines at Maloney Pumping Plant.
	1964	85 mgd Danville piping released for construction.
	1964	Arthur Murray retires from EBMUD.
	1965	Water Resources estimates 120 mgd ultimate.
Aug.	1965	CPC for authorization to design released
Dec.	1965	Ed Carville completes analysis of Danville plant.
Jan.	1966	Ran Pierce comments on Carville's analysis.
	1966	Danville plant hits 11 mgd demand.
Mar.	1966	Noise level investigations started on pumps
Aug.	1966	Pierce writes manufacturers concerning sound level specification.
Sept.	1966	Community meeting.
Sept.	1966	Pierce comments on the above meeting.
Sept.	1966	Noise specifications written.
Sept.	1966	Bids released for pumps and motors.
Oct.	1966	Bids opened on pumps and motors.
Oct.	1966	CPC to proceed released.
Jan.	1967	Work authorization to construct Danville Pumping Plant released.
May	1968	400 hp pumps and motors received in USA.
May	1968	Pump tests begun.

SUGGESTED QUESTIONS

1. In any design project there are certain design constraints; the weight of the product may not exceed a certain value, or the size must be within a given volume, etc. In the case of the selection of the pumps, what were Mr. Carville's design constraints?

2. Why did Mr. Carville elect to purchase pumps rather than design pumps specifically for the plant?

3. The pumps selected were two 400 hp pumps and one 1000 hp pump, giving the plant a total power rating of 1800 hp. Why did Mr. Carville select this particular combination of pumps instead of two 900 hp units or three 600 hp units?

4. How did Mr. Carville become aware of the design constraints for this particular problem?

5. It is not anticipated that the 1000 hp unit will be required for at least two years following its date of installation. Why didn't the district delay purchase of the 1000 hp unit until such time as it would actually be needed?

6. You have been told that the noise level at a distance of 30 feet from a given pump must be less than 40 db. Actual measurements taken 3 feet from the pump indicate a noise level of 100 db. What must you do to insure a 60 db drop in a distance of 30 feet?

7. Noise considerations probably cost the district $50,000. This is the anticipated cost differential between the actual contract and a contract in which noise would not be a consideration. Was the district justified in spending the additional money? Explain.

8. The pumps and motors were purchased to a performance specification. At the time of receival the pumps were not tested, but were simply shipped to the pumping plant site for installation by the contractor. What will Mr. Carville do if the units fail to perform as advertised?

9. The specification to which the pumps and motors were purchased was a performance rather than a design specification. There is nothing in the specification on impeller angle, impeller thickness, bearing size, or mounting flange size. Instead, the specification calls for units to deliver a certain amount of water in a certain amount of time while pumping against a given head. Was the specification written this way because Mr. Carville is basically lazy, or is there some good reason for specifying performance rather than design? Explain.

10. Why was the piping for the pumping plant released to construction before the pumping plant was designed?

LIST OF EXHIBITS

Exhibit 1. Examples of Pump Performance Curves

Exhibit 2. A Large Horizontal Split Case Pump and Motor

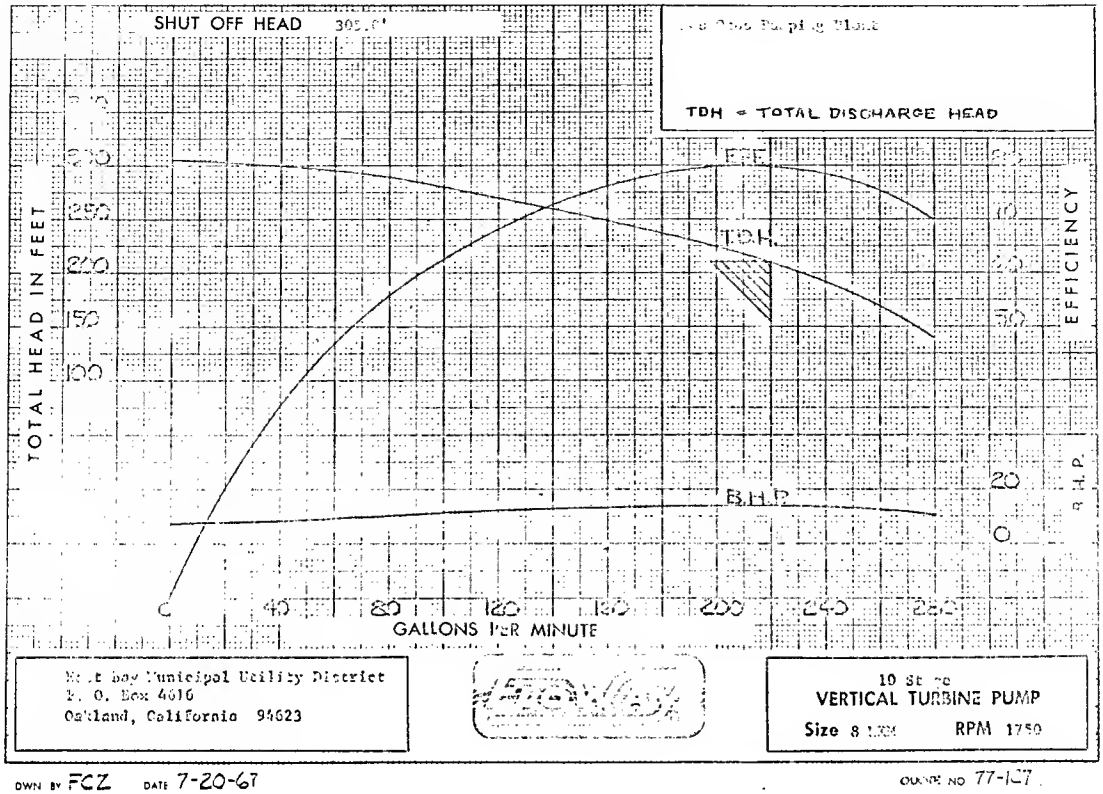
Exhibit 3. A Vertical Pump with Vertical Drive

Exhibit 4. Mr. Carville's Analysis for the Expansion of the Danville Pumping Plant

Exhibit 5. Mr. Pierce's Letter to Motor and Pump Manufacturers and Replies from Three Companies

Exhibit 6. Dr. Soroka Comments on the Noise Problem

Exhibit 7. Mr. Pierce Summarizes the Property Owners Meeting



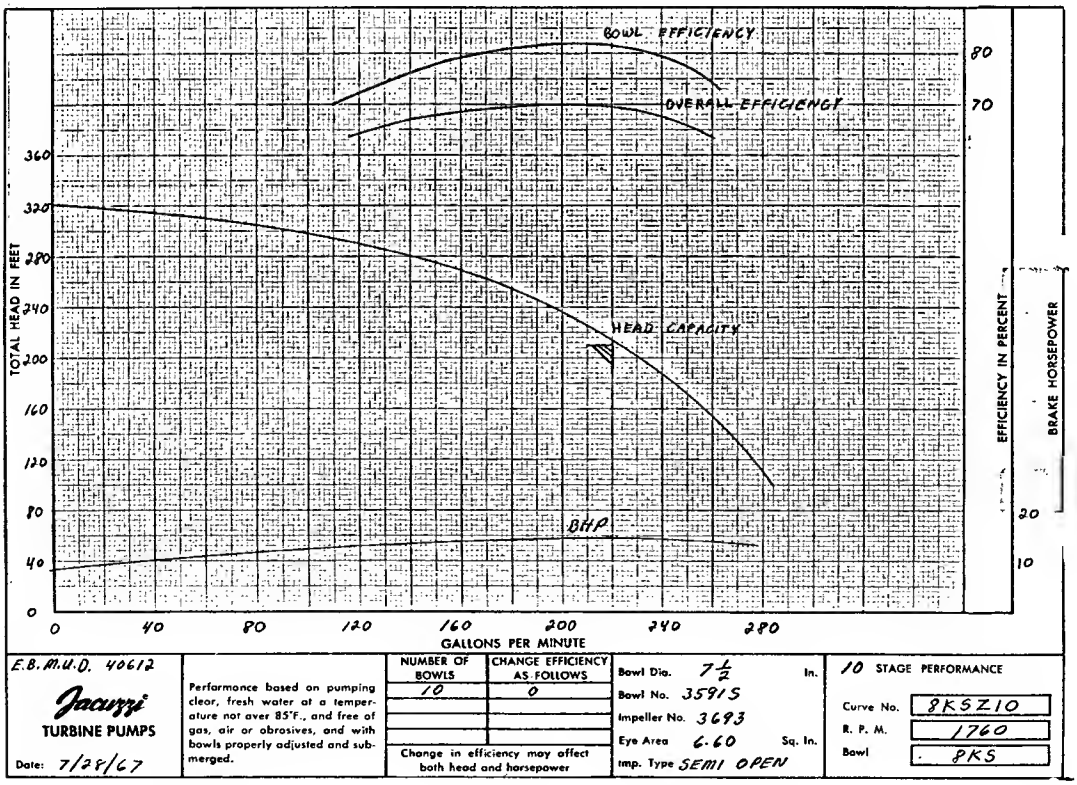


Exhibit 1. Examples of Pump Performance Curves.

Type LN, single stage, capacity to 50,000 gpm or larger, heads to 550 feet.

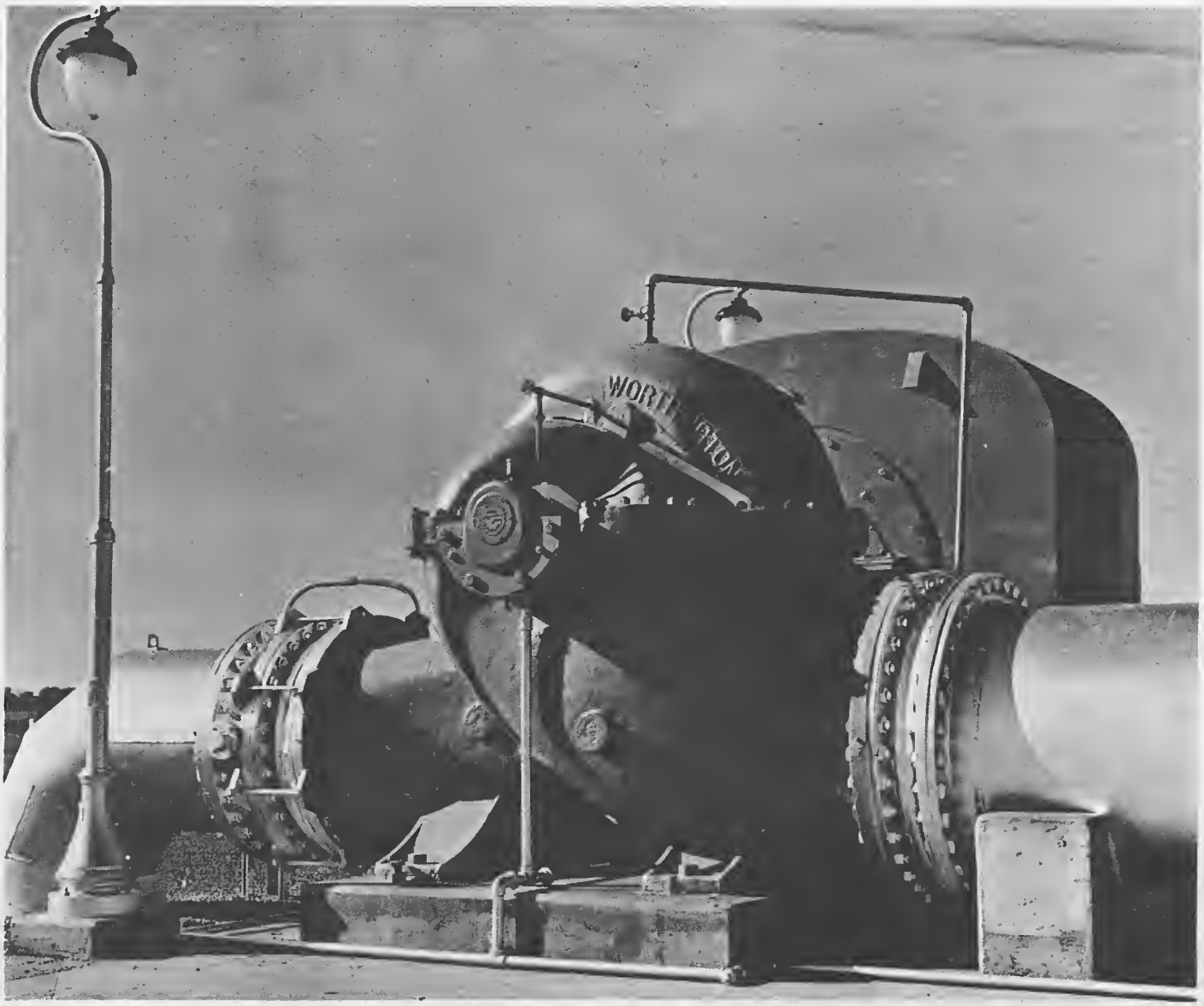


Exhibit 2. A Large Horizontal Split Case Pump and Motor

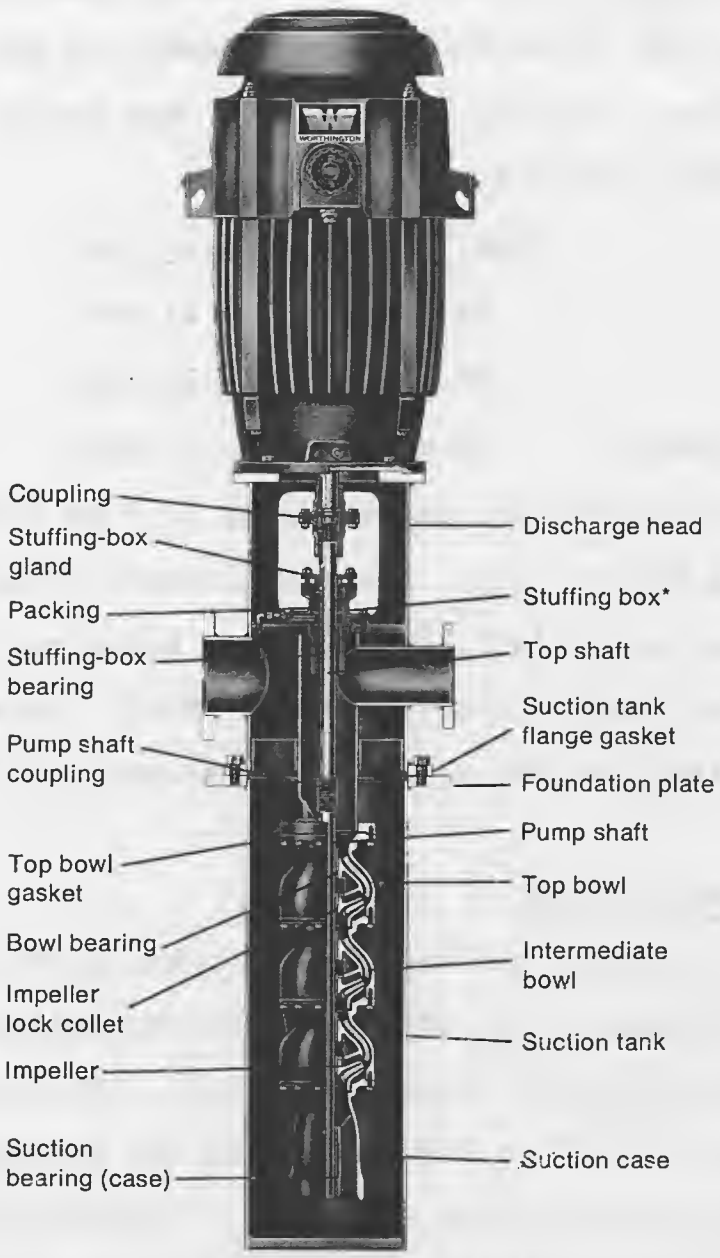


Exhibit 3. A Vertical Pump with Vertical Drive.

DRAFT
12/16/65
EJC:rf

ECL 160

ANALYSIS OF DANVILLE PUMPING PLANT EXPANSION

Reports from Water Resources and Planning Division predict rapid population expansion and water usage in the Danville-San Ramon area. Average usage was 6-7 mgd during the summer of 1965. The predicted usages are:

	Max. Day	Avg. Day	Min. Day
1968	22 mgd	11 mgd	5 mgd
1975	35 mgd	18 mgd	11 mgd
2020 (ultimate)	120 mgd	60 mgd	30 mgd

Storage in Danville zone is presently 17.5 mg (Danville + Green Valley Reservoirs). Alamo Reservoir (10 mg) is scheduled for construction in 1971, and Sycamore Reservoir (3 mg) is scheduled for construction between 1972-76. This storage gives less than one day reserve for maximum day.

EXISTING PUMPING PLANT

It is desirable to keep the existing pumping plant in service for several years, since it allows considerable flexibility at low plant rates for winter operation. The average minimum winter rate for 1965 is 1.5 mgd, while the proposed plant would operate at a minimum of 13 mgd. Projected minimum rates indicate that the old pumping plant will not be needed after 1970 if the new plant is built.

Danville Pumping Plant presently consists of 5-150 hp submersible pumps which have a nominal capacity of 10 mgd. One 250 hp - 5 mgd pump is presently being transferred from San Ramon Pumping

Plant to Danville. This unit will be returned to San Ramon upon completion of the new Danville construction.

The present plant has a very poor maintenance history. At the suggestion of M&E Maintenance, Design Engineering has recommended that upon failure of any submersible pump units at any plant, ~~kkak~~ the unit would be replaced with a vertical turbine pump.

By replacing these five pumps with 250 hp vertical pumps, the plant capacity could be raised to 18-20 mgd. Because of small barrels and discharge lines, head losses through the plant would be very high and efficiencies low. The total cost of changing five pumps is estimated at $53,000. The exposed motors of vertical pumps in this size will produce serious noise problems. We would probably be required to build a noise reducing housing over these pumps. Because of present valving, the housing would produce access problems for maintenance. The noise reducing housing would add an additional $6-10,000 to the cost.

Since 20 mgd will not meet the projected maximum day in 1968, adding five new 250 hp pumps does not appear economically justified.

NEW PUMPING PLANT

The present Danville Pumping Plant site has an area of about 0.6 acre, lies approximately 340' west of the Old Danville highway and backs up to the Southern Pacific railroad tracks. The area available for building is irregular in shape and is approximately 100-110' long x 110-120' wide. There is a 10' right of way for an 8" sanitary sewer on the south edge of the property.

Sixty-inch suction and discharge lines have previously been installed and somewhat limit the layout at this site. The suction and discharge lines were sized for an 85 mgd plant and must be considered as marginal for a 120 mgd plant.

This area is slated to be annexed by the City of Walnut Creek in the near future. This may produce zoning problems if additional land is needed.

A 120 mgd plant will require about 7,000 hp at maximum capacity. After initial installation the pumps will be installed in increments of 1,000 hp over a 35-year period.

Pumps of this size can be driven economically either by electric motors or internal combustion engines using natural gas as fuel.

ELECTRIC MOTOR DRIVE

The advantages of electric motor drive are low initial cost, simplicity of design, low maintenance costs and minimum building size. We have considerable experience and few problems in the operation of large motor driven pumps.

The disadvantages of electric drive are: considerably higher energy costs and constant flow pumping.

Electric motor driven pumps can be of two types: vertical turbine pumps and motors, or ~~with~~ centrifugal horizontal pumps and motors. Only vertical pumps and motors are considered here. Horizontal pump and motors are not attractive on this site since they present all the site location problems of gas engine drive pumps and have considerably higher energy costs.

Alternate A, which consists of vertical turbine pumps and motors, would require an underground building approximately 80' x 35' with aboveground motor control center and transformer bank. The building would be enlarged proportionately if the motor control center were placed inside the building. There appears to be no reason to place the transformers underground.

Alternate A	Vertical Turbine Pump - Electric	
	2 - 600 hp initial	31 mgd
	7 - 1,000 hp ultimate	120 mgd

Advantages	Can be built on present site
	Straightforward design
	Lower initial cost
	Low maintenance
Disadvantages	Higher energy costs
	Tight fit on lot
	60" suction piping rather small
	(9.5 fps at 120 mgd)

The present worth of total cost of this plant is tabulated at the end of this report.

Alternate A2 shows energy costs reduced to an average of 1.00¢/kwh. This can only be achieved by off-peak demand pumping to utilize lower rates at night. In order to take advantage of these lower rates, considerably more storage must be obtained since present and projected storage is less than one maximum day. 70 mg would be required for two days' storage at maximum day in 1975 while only 32 mg storage will be available under present plans.

GAS ENGINE DRIVE

The remaining alternatives are for natural gas engines with either horizontal pumps or vertical turbines with right angle drive. The advantages of gas engine drive are: low energy costs and flexibility of operation. A 950 hp gas engine and pump can produce from 13-23 mgd by varying the engine speed. The filter plant operators have been very happy with the flexibility of Maloney Pumping Plant.

The lowest energy costs are obtained on an interruptible service basis, in which case, on site storage of LPG gas is REQUIRED. THIS REQUIRES CONSIDERABLY MORE LAND SINCE 25FT IS required between the LPG tank and any building or property line.

In the present worths tabulated at the end of this report, energy costs are given for both firm industrial and interruptible gas service.

Gas engines produce considerable heat and noise, so that larger ventilating systems and sound control are required. In addition, the building must be much larger with an overhead crane and loading ramp.

Alternate B, which consists of natural gas engines with horizontal pumps, would require a building 140' x 70', buried approximately halfway similar to Maloney Pumping Plant. This would probably be built in three or four stages, with the initial building 80' x 43'.

Additional land must be purchased for this plant design. With LPG storage, the additional land would be 110' long x 145' wide. Without LPG storage, it would be 65' long x 145' wide. This land consists of two parcels. One parcel consists of an abandoned chickenhouse and a portion of a large rear lawn. The second parcel is presently used as a horse paddock. This land may not be available except by condemnation. An existing

8" sanitary sewer must be relocated for this design.

Alternate B	Horizontal Pumps - Gas Engine Drive	
Initial	2 - 950 hp	40 mgd
Ultimate	8 - 950 hp	120 mgd

Advantages	Lower energy cost
	Flexibility of operation
Disadvantages	Higher initial cost
	High maintenance
	Noise problems
	60" suction piping rather small - (9.5 fps at 120 mgd)
	Additional and must be bought
	Clumsy layout for piping
	8" sewer must be relocated.

Alternate C, which has horizontal pumps and gas engines, would require two separate plants; one on the present site and one on a new site. Each plant would have four pump engine units in a building 80' x 65' buried approximately halfway.

The initial installation would be two pump-engine units in a 80' x 43' building. With four pumps, the plant on the present site could produce 67 mgd with a spare unit. This would satisfy the ultimate average day, and the maximum average day to 1990.

This design would leave no room for storing LPG gas needed to qualify for interruptible rates. An additional strip of land 36' long x 145' wide would be required for LPG storage. This land is presently occupied by an abandoned chicken house and a small portion of a rear lawn, all under one ownership. This land may not be available except by condemnation.

Alternate C	Horizontal Pumps	- Gas Engine Drive
Initial	2 - 950 hp	40 mgd
Ultimate	4 - 950 hp	53 mgd (67 mgd with future new piping, 82 mgd w/o spare unit)

and

Build another plant equal in size at some other site and at some later date.

Advantages	Lower energy cost
	Flexibility of operation
	Can use present site for initial installation.
Disadvantages	Higher initial cost
	High maintenance
	Noise problems
	Suitable site may be hard to find

Alternate D, which consists of horizontal pumps with gas engines, would require the abandonment of the present site and purchasing a new site.

There appears to be considerable vacant land in the neighborhood of the present plant, but none appears to be for sale. Most of the land is presently in orchards.

The large lot (325' x 185')(1.8 acres), directly between the highway and the present pumping plant is vacant and ~~the highway and the pumping~~ graded clean. It is rumored to be the site of a large apartment house, but it might be available for a price. ($30,000 per Ken Appel)

Alternate D	Horizontal Pumps - Gas Engine Drive
	Abandon present site (except maintain existing plant). Build new plant at new site, which remains to be found.
Advantages	Lower energy cost
	Flexibility of operation
Disadvantages	Higher initial cost
	High maintenance
	Noise problems
	Suitable site may be hard to find.

Alternate E, which consists of vertical turbine pumps driven by gas engines through a right angle gear drive, would require a building 70' long x 84' wide, buried approximately halfway. This would probably be built in two stages with the initial building 70' x 48'.

This design is not attractive. The piping layout is very clumsy and the right angle drive reduces efficiency by 2-1/2 to 3-1/2%.

This design would leave no room for storing LPG gas needed to qualify for interruptible rates. An additional strip of land 36' long x 145' wide would be required for LPG storage. This land is presently occupied by an abandoned chicken house and a small portion of rear lawn, all under one ownership. This land may not be available except by condemnation.

Alternate E — Vertical Turbine Pump - Gas Engine
Right angle gear drive

Initial	2 - 950 hp	40 mgd
Ultimate	8 - 950 hp	120 mgd

Advantages
- Lower Energy Cost
- Flexibility of operation
- Can be built on present site.

Disadvantages
- Higher initial cost
- High maintenance
- Noise problems
- 60" suction piping rather small - (9.5 fps at 120 mgd)
- Clumsy layout for piping
- Additional land needed for LPG storage.

RECOMMENDATION:

Existing Plant

Keep existing Danville Pumping Plant in service for 5-10 years. If a submersible unit fails before new plant is in service, replace it with a vertical turbine pump. Do not replace units if they fail after the new plant is in service. If the new plant is powered by electricity, maintain separate meters unless it is apparent that the existing plant will be in service more than eight years.

New Plant

Build plant with horizontal pumps and natural gas engines on present site (Alternate B).

If the land required for Alternate B cannot be obtained, build half the plant on existing site and half on new site (Alternate C).

A sixth alternative, Alternate F, would consist of horizontal pumps, half of which are driven by horizontal electric motors and the other half by natural gas engines.

The layout of this plant is substantially equal to that of Alternate B. The building would be 140' x 70', buried approximately halfway similar to Maloney Pumping Plant. This would probably be built in three or four stages, with the initial building 80' x 43'.

Additional land must be purchased for this plant design. With LPG storage, the additional land would be 110' long x 145' wide. Without LPG storage, it would by 65' long x 145' wide. This land consists of two parcels. One parcel consists of an abandoned chicken house and a portion of a large rear lawn. The second parcel is presently used as a horse paddock. This land may not be available except by condemnation. An existing sanitary sewer must be relocated for this design.

Alternate F - Horizontal Pumps

Initial - 1 - 950 hp gas engine and pump
1 - 600 hp electric motor and pump

Ultimate - 4- 950 hp gas engines and pump
4-1,000 hp electric motors and pump

Advantages: Two power sources provide protection against power or gas failure flexibility of operation.

Alternate F - Continued.

Disadvantages

Higher initial cost

High energy cost

High Maintenante

Noise Problems

60" suction piping rather small - (9.5 fps @ 120 mgd)

Additional land must be bought

Clumsy layout for piping

8" Sewer must be relocated

DANVILLE PUMPING PLANT EXPANSION
PRESENT WORTH @ 3-1/2%
28 Years 1967 - 1996

1/12/66
EJC

Alt.		Rate	Energy Cost	Equipment Cost	Maintenance Cost	Building Cost	Land Cost	Pipeline Cost	Total Cost	Remarks
A1	Electric Vertical turbine pumps	A-13	$1,434,500	$145,700	$ 13,600	-	-	-	$1,593,800	
A2	Electric Vertical turbine pumps	1.0¢/kwh	1,213,000	145,700	13,600	-	-	-	1,372,300	Not possible under pre[illegible] plan
B1	Gas Engine Horizontal Pump	Interr.	709,400	222,300	148,600	220,000	20,000	-	1,320,000	
B2	Gas Engine Horizontal Pump	Firm	791,000	222,300	148,600	220,000	15,000	-	1,397,000	
C1	Gas Engine Horizontal Pump	Interr.	709,400	222,300	148,600	240,000	45,000	36,000	1,401,000	Half on present site; half on new site.
C2	Gas Engine Horizontal Pump	Firm	791,000	222,300	148,600	240,000	35,000	36,000	1,473,000	
D1	Gas Engine Horizontal Pump	Interr.	709,400	222,300	148,600	220,000	45,000	50,000	1,395,000	Abandon present site
D2	Gas Engine Horizontal Pump	Firm	791,000	222,300	148,600	220,000	45,000	50,000	1,477,000	Find new site
E1	Gas Engine - Vertical Pump	Interr.	730,000	245,000	148,600	190,000	[illegible],000	-	1,314,000	
E2	Gas Engine - Vertical Pump	Firm	814,000	245,000	148,600	190,000	-	-	1,398,000	
F	Horizontal Pumps 4 Gas engines 4 Elec. Motors	Interr. 1.0¢/kwh	969,500	191,700	110,000	220,000	20,000	-	1,511,200	

Alternate A2 shows energy costs reduced to 1.0¢/kwh from standard PG&E A-13 Rate Schedule. This required pumping at off-peak hours and considerably more storage than is now available. 70 mg would be required for 2 days storage in 1975 while only 32 mg storage will be available under present plans.

Gas rates are from PG&E Schedule G 50 Interruptible, and Schedule G 40 B Firm Industrial.

Building cost is actual cost less cost of structure required for vertical turbine pumps (Alt. A).

Pipeline cost based on 500' of additional 60" pipe.

ECL 160

July 8, 1966

Reliance Electric and Engineering Co.
24701 Euclid Avenue
Cleveland, Ohio 44117

Gentlemen:

Many of our installations are in residential areas, often in neighborhoods where the ambient noise level at early hours of the morning is quite low. We have found that our facilities must conform to the neighborhood. A number of things have been done that help to keep the noise of our facilities low. The pumping units have been enclosed or put underground. Sound barriers and sound absorbing materials have been used. Special piping and foundation designs have been made. These actions have been successful in most cases. They would be even more successful if the sound pressure level of the pump and motors could be reduced, especially in certain frequencies.

We are in the initial phases of the design of a new pumping plant. Sound control is a requirement. Attached is a proposed specification for the motors of that plant. You will note that there is a paragraph regarding the sound pressure level. Also attached is a graph showing the desired maximum motor sound pressure level (the sum of an acceptable sound pressure curve and expected attenuation), and also graphs of actual motors now in use. It is always hard for the ear to identify the portions of the sound which is annoying, but I have the impression that the peaks in the 1,000-2,000 cycle range cause us the most trouble.

Will you please review this specification. Your comments and suggestions will be very much appreciated. Specifically, I would like to know:

1. Is this a practical requirement?

2. If not, what practical requirement can be made?

Reliance Electric and
Engineering Co.

July 8, 1966

3. Would you bid on a specification with a sound pressure level requirement?

4. Will such a requirement add to the price? If so, approximately how much?

5. Will it affect the delivery? If so, approximately how much?

6. Does size, speed, or voltage affect your attitude toward a sound pressure level requirement?

If a practical sound pressure level requirement can be worked out, we will probably include it as part of all motor specifications.

This is being sent to the motor and pump manufacturers with whom EBMUD regularly does business.

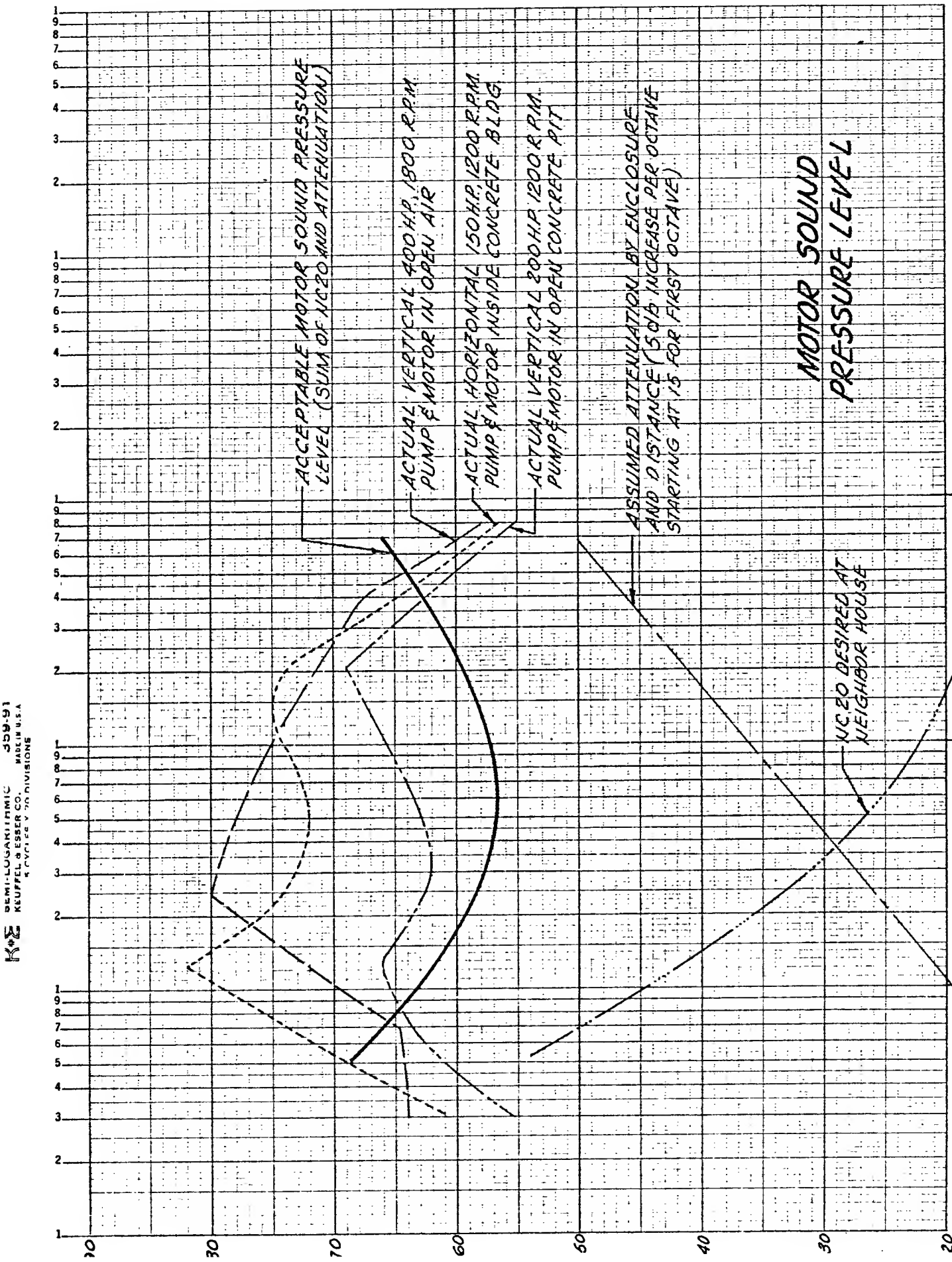
Yours very truly,

Ransom A. Pierce
Senior Mechanical Engineer

Enclosures

RAP:rf

cc: Gen. Files
L. B. Hertzberg/Eng. Files
R. A. Pierce



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THE ELECTRIC PRODUCTS COMPANY

Engineers & Manufacturers of Electrical Machinery and Power Systems

REPLY TO: 1255 POST STREET, SUITE 605
SAN FRANCISCO, CALIFORNIA 94109
TELEPHONE: PROSPECT 5-6010 AREA CODE 415

1725 CLARKSTONE ROAD
CLEVELAND, OHIO 44112
216/481-1500

June 21, 1966

East Bay Municipal Utility District
2130 Adeline Street
Oakland, California 94623

Attention: Mr. Ransom A. Pierce
Senior Mechanical Engineer

Subject: Pump Motor Noise Level

Dear Mr. Pierce:

We are pleased to acknowledge receipt of your letter dated May 27, and to submit our reply to your questions as follows:

No. 1 - In our opinion your restriction on motor noise are not practical, and we reference you to military specification MIL-STD-740B, dated January 13, 1965.

No. 2 - Practical noise level limits can be found in this referenced specification, under GRADE D, paragraph 5.2.4.

No. 3 - EP would bid on a specification with a sound pressure level requirement, but we would find it necessary to clarify the limits that could be guaranteed for any particular design, and this is possible only after each motor rating has individually been reviewed by our engineers.

No. 4 - A price increase to the standard induction motor prices would be expected, and the magnitude of such price increase would depend upon the extent that the standard design would require modification, and whether or not special dies and other tooling would become involved. Naturally the number of motors involved will determine the price increase per motor depending upon the amortization of the

"SPECIALIZATION PLUS EXPERIENCE MEANS PROVED PERFORMANCE"

additional tooling cost and engineering expense which must be financed by a specific order. Here again the final review of a specific design may or may not require extensive engineering and tooling changes, so that the total price increase will be directly effected by the final sound pressure level limits that can be tolerated, and the severity of the penalty for failing to meet these requirements when equipment is finally placed in service.

No. 5 - The effect on delivery will be approximately 4 weeks longer than normal delivery in order to permit time to conduct the engineering design review and make whatever changes are believed desirable in order to maintain operation within specifications. If special tooling is required then this delivery could be extended to 6 or 8 weeks longer than that usually expected for standard motor construction.

No. 6 - Generally higher speed, larger size units will increase noise level, which brings us back to our original problem of reviewing each motor rating individually, and even then it may be necessary to make final changes on tests such as altering fan construction and baffling within the motor enclosure.

I would estimate that in most cases the price increase could be held to within 10% of standard motor pricing, but this would depend on whether or not you could live within the requirements of MIL-STD-704B, GRADE D, paragraph 5.2.4.

It might be advisable to submit initial specifications on standard motor design with alternates based on the low noise level conditions for the next few jobs until a price pattern has been established resulting from the individual motor manufacturers having an opportunity to review specific motor designs and to prepare their proposals accordingly.

As far as the specific 400 HP, 1200 RPM vertical solid shaft motors are concerned for the Danville Pumping Plant, we are most definitely interested in quoting based on a sound pressure level requirement, however, our proposal would be modified as above, and it would be your decision as to whether or not MIL-STD-740B, GRADE D, paragraph 5.2.4 would meet with the tolerances acceptable to your

situation.

Sincerely,

L. C. Madison
Regional Sales Manager

LCM:dd

ECL 160

Westinghouse Electric Corporation

410 Bush Street
San Francisco, Calif. 94108
Telephone: EXbrook 2-5353

July 7, 1966

East Bay Municipal Utility District
2130 Adeline Street
Oakland, California 94623

Atten: Mr. Ransom A. Pierce

Gentlemen:

Reference your letter to me dated 5/27/66 and our telephone conversation of 7/1/66.

I have the following comments in order of your questions per letter of 5/27.

1. Our factory ~~is~~ has determined that this is not a practical requirement.

2. We cannot quote on a sound level requirement which combines motor plus driven auxiliary, plus effects of installation. We can only be responsible for motor as tested at no load. Our limits on a 400-HP, 6-pole motor would be as follows:

Octave Band	25/75, 76 DB
	75/150, 79 DB
	150/300, 80 DB
	300/600, 86 DB
	600/1200, 86 DB
	1200/2400, 85 DB
	2400/4800, 75 DB
	4800/9600, 67 DB

3. Yes, we would bid on a specification with a sound pressure level re-requirement, provided they do not go below valves as per comment No. 2 above, and on the basis of no load and for motor as described.

4. The price of the motor is not affected unless you would want us to run a special test to determine that we have met the specification. If this is required, there is a price adder of $525.00.

5. This would not affect delivery unless the above test (as stated in comment No. 4 above) is required. If this test is required, add approximately 2 weeks to the delivery.

6. Your question as to whether size, speed or voltage affect our attitude toward a sound pressure level requirement. Yes, particularly speed and enclosure. For example, the following is typical based on 450-HP and C scale readings:

	DRIP-PROOF & WPI			T E F C			WPII		
RPM	3600	1800	1200	3600	1800	1200	3600	1800	1200
DB	93	86	85	96	93	90	89	85	83

The above information is given for comparison only. We recommend each rating be considered on its own merits.

If we may be of any further assistance, please feel free to contact us.

Very truly yours,

R. C. Howes
Sales Engineer

ft

GENERAL ELECTRIC COMPANY

SHELLMOUND ST., OAKLAND, CALIFORNIA 94608 . . . TELEPHONE AREA CODE 415—654-7117

INDUSTRIAL SALES DIVISION

July 29, 1966

East Bay Municipal Utility District
2130 Adeline Street
Oakland, California

Attention: Mr. Ransom A. Pierce

Gentlemen:

Our engineering staff at our San Jose Motor Plant have studied your letter of May 27, and the specifications that you propose to cover sound levels. Their comments on your six questions are as follows and are in the same order as in your questions.

1. We do not feel that this is a practical requirement.

2. It is quite difficult to answer this question directly since sound is a very elusive characteristic. We might explain, however, that we would offer a proposal on a motor rated 400 hp, 1200 rpm, Nema WPI, 2300 volts or 4160 volts if the sound pressure level were increased 20 db above the values shown on the sound pressure level curve. This would be measured three feet from the motor.

 We might add at this point that we would do everything possible when building this motor to make it as quiet as we know how without changing any of our basic parts which go into the motor. We would do this type of design work without any additional charge. However, if any special punchings or any special castings would be required, we would have to charge for the development of the same. It is our opinion as of this moment that no new parts would be required if we could maintain the 20 db higher requirement as stated above.

3. & 4. We believe that the above also answers questions three and four.

5. Based upon no new parts being required but engineering design work only, it is estimated that the delivery could be affected as much as four to five weeks.

RECEIVED
M & E DESIGN SECTION
JUL 29 1966

6. Size, speed and voltage all affect the sound pressure level value.

 Speed, of course, has an affect. However, you cannot always say that slower the speed the lower the noise level, simply because certain punching combinations can have higher magnetic noise than another.

 Secondly, in general, noise level increases as the size or hp of the motor increases.

 Voltage also has an affect on sound level since 440 volt or random wound motors are normally less noisy than form wound motors which are of the 2300 or 4160 volt class.

In reference to the specifications themselves our engineers wish to comment as follows:

1. General. It is our general policy that on motors rated 2300 volts for outdoor installation, WPNEMA I that we recommend that the motors be with sealed insulation. On 4160 volt outdoor motors, we insist that the motors be with sealed insulation or our warranty will not apply.

2. Motor Bearings. The specifications state that the thrust bearing shall be designed, etc. We would like to have this corrected to say that the bearing system will be designed to withstand upthrust as well as downthrust, etc. The reason for this, of course, is that we take momentary upthrust by the lower guide bearing and not by the thrust bearing itself. Furthermore, they simply indicate that the bearing should be designed to withstand upthrust and make no indication as to how much and for how long a time. We would therefore indicate to them that they should say motors to be suitable for thirty percent momentary upthrust. The five year average life continuous operation is satisfactory.

3. Motor Winding Thermal Protection. The specifications indicate that sensors shall be General Electric Thermotector, etc. It is to be pointed out that on 2300 volt or 4160 volt motors which are form wound construction that Thermotectors do not apply. Thermotectors are used only on 440 volts random wound type machines. We would like the specifications to indicate that the Cutler Hammer device per their bulletin 13549B1 be acceptable. We have used this device many times and is our standard device for form wound 2300 or 4160 volt motors. We have also had some experience with Texas Instruments 2TM devices and at the present time these devices have not been fully tested and we would not wish to use them on General Electric vertical motors at the present time. We are working with Texas Instruments and we hope to have a device which will be acceptable to us in the near future.

4. Sound Pressure Level. This point has been extensively covered in the answers to the questions one through six.

We hope that this reply to your letter contains some information of assistance to you in preparing your specifications. It has been a pleasure to work with you on this question and if you have further ideas please do not hesitate to call upon us as we shall be pleased to work with you in any extent that we can be of assistance.

Yours very truly,

W. H. Haley
Sales Engineer

Walter W. Soroka Sc.D.
1485 Rancho View Drive
Lafayette, Calif. 94549

August 10, 1966

Mr. George Ivelich
Hardison & Komatsu, Architects
522 Washington St.
San Francisco, Calif.

Project: EBMUD Projected Danville Pumping Plant

Dear George:

Ed Carville submitted to me measurements of ambient noise made in the southwest corner of the Danville property on 7/29/66 between 12:05 AM and 1:00 AM. These were measurements with pump unit #3 only in operation (Fig. 1) and with no pumps in operation (Fig. 2). The NC level of 32 for background noise in Fig. 2 is raised to NC40 with pump unit no. 3 only in operation.

This represents the current situation. To predict the future situation with the projected pumping plant in operation, I have examined available data on electric motor noise and the building design and conducted a series of detailed calculations to estimate external noise levels. I understand that the pumps will be submerged with only the motors exposed to the building interior so that motor noise would be predominant.

Three motor specifications were considered in this analysis, namely,

(1) MIL-STD-740B (SHIPS), 13 January 1965, Airborne grade D
(2) MIL-STD-&$)B (SHIPS), 13 January 1965, Airborne grade B
(3) Letter dated July 7, 1966 from R.C.Howes of Westinghouse Electric Corporation to Mr. Ransom A. Pierce of EBMUD, which quotes limits on octave band SPLs at no load for a 400-HP, 6-pole motor. Sound power levels re 10-12 watts for the three classes of motors are shown in Table I.

TABLE I

Center Frequency of Octave Band c/s	Grade D Motor PWL	Grade B Motor PWL	Westinghouse July 7, 1966 Letter PWL*
31.5	122	97	-
63	117	91	90
125	112	86	93
250	107	82	94
500	97	79	100
1000	92	78	100

Center Frequency of Octave Band c/s	Grade D Motor PWL	Grade B Motor PWL	Westinghouse July 7, 1966 Letter PWL*
2000	92	77	99
4000	92	76	89
8000	92	75	81

[*The power levels in this column were obtained by adding 14 decibels to the sound pressure levels quoted in the Westinghouse letter. There is also a 1/4-octave shift in octave band midfrequency values to convert the quoted octave bands to the International Standards Organization (ISO) preferred frequencies used in the military standards.]

Estimating sound absorption coefficients for rough concrete for the building interior, ranging from 0.01 at 31.5 c/s to 0.05 at 4000 c/s, and allowing for absorption by equipment in the building, estimated to range from 100 sabins at 31.5 c/s to 1000 sabins at 8000 c/s, reverberant field octave-band sound pressure levels were determined inside the building for a single Grade D motor in operation. These are shown in Col. 2 of Table II. With five motors in operation, as eventually anticipated, the octave band sound pressure levels of Col. 2, Table II, would be raised by 10 $\log_{10} 5 = 7$ decibels. These are shown in Col. 3, Table II.

Estimated sound transmission loss values for a 12" concrete wall are listed in Col. 4 of Table II.

The sound pressure level just outside the building for 5 motors running is estimated by subtracting the transmission loss of the wall from the SPL's inside, and subtracting an additional 3 decibels to account for radiation into a free half-space instead of into a closed room.

Columns 5, 6 and 7 of Table II thus show the sound pressure levels estimated just outside the building walls for the Grade D, Grade B and Westinghouse motors (5 pumps operating).

TABLE II

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Center Frequency of Octave Band	SPLs inside Bldg with One Grade D Motor Operating	SPLs with 5 Grade D motors Operating	STL of a 12" Concrete Wall	SPL Outside Bldg. with 5 motors operating Grade D	Grade B	Westinghouse
31.5	105 - 86	112 93	28 19	81	56	-
63	97 74	104 81	33 23	68	42	41 51
125	92 51	99 59	41 41	55	29	36 36
250	87 41	94 48	45 46	46	21	33 33
500	77 31	84 38	55 46	26	-	29 38
1000	77 31	84 38	61 46	20	-	27 42
2000	68 20	76 28	69 43	-	-	10
4000	68 20	76 28	70 43	-	-	-
8000	62 22	79 29	72 41	-	-	-

The estimated levels of Cols. 5,6,7 are shown plotted on the NC curves of Fig. 3.

The Grade D specification permits a level outside the building of the order of NC55, governed by the fact that intense noise is allowable in the 31.5 cycle octave band. Intense noise at such a low frequency seems hardly realistic for conventional motors. My own measurements on a few installations during a field trip with Ed Carville indicated peaks at intermediate frequencies, with considerable fall-off in the 31.5 and 63 cycle bands. The same seems to be true of measurements by EBMUD on the 1250 HP South Bay Aqueduct and the 400 HP Summit South Pumping Plant. The Westinghouse motor used in the above analysis shows the same characteristic, with a peak in the 300-2400 cycle range and considerable fall-off on both sides of this fairly flat peak.

Hence, I feel that Grade D is unrealistic at the low frequency end and inflicts severe penalties on the structure if the structure is to be designed to insulate to such a high degree at such low frequencies.

To bring the low-frequency end of the Grade D motors down to NC 30 outside the building would require roughly an additional 15 to 20 db of sound transmission loss in the structure, over and above that provided by 12-inches of concrete. If this is to be done by thickening the solid concrete, the thickness estimated would be about 50 inches, on the basis of the mass law (about 5db increase in transmission loss for each doubling of the mass of a solid partition).

Another possibility would be to enclose the motors in a box which will give 20 db transmission loss in the 31.5 c/s octave band. This would require something of the order of 5-inches of concrete or an equivalent weight of lead, heavily treated inside with a dense Fiberglas (6 inches of PF618- about 10 lbs/cu ft density) to avoid magnification of the sound by the enclosure.

The roof of the building is of 6-inch concrete, with hatch covers of 4-inch thickness, as now shown on the drawings. This is pretty thin and the levels outside the roof surface will be some 6 db higher than those outside the walls. This makes it all the more important to avoid unnecessarily penalizing the structure because motor specifications are too unrealistic in anticipating such extreme levels of noise in the 31.5 and 63 cycle octave bands.

With the Westinghouse proposed motor, adding 6 db to its noise level outside the building (to account for the thinner roof) would bring the NC value to an estimated 32, this value being controlled by the 1000-cycle band. In this frequency range attenuation with distance would be much more pronounced than in the case of the 31.5 cycle band, which would attenuate relatively slowly. This is all the more reason for looking realistically at just how much sound power is actually produced by a conventional pump motor in the 31.5 and 63 cycle octave bands.

Although my calculations have not included acoustical materials within the structure (they would be substantially useless in normal thicknesses for absorbing sound at 31.5 c/s), nevertheless it would be advantageous for the comfort of operators and to help reduce the higher frequency levels in the building if the ceiling were covered with a two-inch thickness of, say, 1.5-#b density Fiberglas.

Where openings penetrate the building for ventilation purposes, package attenuators (such as the Koppers Co. "Aircoustat" or IAC's "Quiet-Duct") should be used. To attenuate in the very low frequency region, I estimate that an attenuator 16-ft long would be required. For motors (and fans) with less intense low-frequency levels an 8-ft long attenuator should prove to be adequate. These are estimates at this time and if more precise specifications are needed they would have to be based on more specific information on fans and motors.

The doors will be the weak links in the structure for sound control. If we go along with the Grade D specifications, for low frequency sound insulation I anticipate that double sets of doors will be required, especially the large doors.

With Westinghouse motors as specified in their letter, single sets of acoustic doors such as the set on the Maloney plant, should prove adequate.

I trust this letter answers questions sufficiently to permit decisions at this time regarding the Danville pumping plant design prospects.

I am due back home on September 23 and should be pleased to go into this matter in further detail should you require it.

Sincerely yours,

Walter W. Soroka

Walter W. Soroka

ECL 160
September 15, 1966

MEMO TO: FILES

FROM : R. A. Pierce, Senior Mechanical Engineer, M&E Design Section

SUBJECT: Danville Pumping Plant, Meetings with County Planning Staff

1. On August 25 a meeting was held at the offices of the Contra Costa County Planning Commission with Mr. Dehaesus. Messrs. George Ivelich, representing Hardison & Komatsu, Architects, Ed. Carville, Associate Mechanical Engineer, and Ran Pierce, Senior Mechanical Engineer, represented the District. One set of prints showing the architect's renderings of the proposed Danville Pumping Plant enlargement was given to Mr. Dehaesus for his file. The initial and final installations of the plant were explained including type of construction, number and size of the pumps, noise levels to be expected, landscaping and appearance. The necessity for Planning Commission approval was discussed and Mr. Dehaesus indicated that such approval would not be required, that only the regular building permit would have to be obtained. Mr. Dehaesus suggested that Mr. Young, a member of the Planning Commission and a neighbor to the pumping plant, be shown the plans in advance of asking for permits.

2. On September 1 a meeting was held at the offices of the Contra Costa County Planning Commission by parties planning a development of approximately 150 units on parcels totaling approximately 13 acres adjacent to the Danville Pumping Plant property. The EBMUD was invited to attend. Representing the EBMUD were Messrs. Ken Appel, Right-of-Way Agent, Steve Kodama, representing Hardison & Komatsu, Architects, Ed. Carville, Associate Mechanical Engineer, and Ran A. Pierce, Senior Mechanical Engineer. Representing the property owners and the developers were: Dr. and Mrs. N. E. Betaque; Messrs. & Mmes R. Biggs, Clark, L. G. Geary, Jr.; and Messrs. G. A. MacNeil, A. G. Lockwood, T. Lockwood, D. Campbell, attorney, and R. W. Souza. Mr. Dehaesus represented the Planning Commission.

The District was invited to explain its plans for the pumping plant property. Mr. Pierce showed the drawings prepared by the architect of the proposed pumping plant development, explained what was planned, the initial and ultimate installations, and the construction time schedule. A number of questions were asked exploring other circumstances of the facility. Especially was there concern that noise might be a problem. Mr. Pierce explained the steps that had been taken to assure that the noise level in the vicinity of the pumping plant

MEMO TO: FILES September 15, 1966

would be no higher than the present noise level with pumps stopped. In this connection the present plant was pointed out as causing a noise problem. This was explained as being caused by a temporary pump which will be removed when the new plant is operating. In the meantime this temporary pump will be run only during the day except during next summer's peak demands and then at night only if absolutely required. All questions regarding the pumping plant appeared to be friendly and the answers given appeared to satisfy the questioner. Attached is a letter from Mr. R. W. Souza, the realtor, which suggests that all questions were settled.

After the EBMUD plans were explained and questions answered, those representing the EBMUD left since they were not involved in the remainder of the meeting.

R. A. Pierce

Attachment

RAP:rf

cc: Gen. Files (2)
Rich Komatsu
Bud Tanner
Ken Appel
D. G. Larkin
R. A. Pierce